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(54) **ELECTROSTATIC COATING**

ELEKTROSTATISCHE BESCHICHTUNG

REVETEMENT ELECTROSTATIQUE

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Description

[0001] The present invention relates to a method and apparatus for the electrostatic coating of electrically poorly conducting substrates. It finds particular application in the coating of solid pharmaceutical dosage forms such as tablet cores, capsules, granules and beads with particulate coating materials, including powders and droplets of liquid.

[0002] The use of electrostatic techniques to coat electrically conductive substrates, such as metal objects, is well known and successful. The coating, such as droplets of liquid paint, is electrically charged by applying a potential difference to it and is attracted to the earthed substrate.

[0003] The conventional electrostatic coating technique described above has not been successfully applied to the coating of pharmaceutical tablet cores or other poor electrical conductors, generally those with a resistivity of more than 10^{10} - 10^{15} Ωm. Proposals have been made in which tablet cores are earthed, and a powdered coating material is directed at them through a nozzle which imparts an electrical charge to the powder. The powder coating is then fused to give a uniform coat. This method has been found inefficient, since adequate earthing of the cores has not been achieved, and the charge on the powder accumulates on the surface of the cores, repelling further charged powder. Even if the cores are carried on for example an earthed conveyor belt, the poorly conducting nature of the cores allows charge to build up.

[0004] Further, the bulk of the powder (95% in the case of corona charging) is uncharged, and does not land or stay on the cores, and must either be recovered or wasted. These difficulties lead to non-uniformity in the weight and thickness of the coating applied to the cores. This is pharmaceutically unacceptable, in particular when the core coating plays a significant role in the timing of the release of the pharmaceutical into the body after ingestion.

[0005] Improvements have been proposed, for example in WO 92/14451 which proposes moistening the cores with water prior to spraying with the charged powder, to improve the earthing of the surfaces of the cores and to encourage the powder, once on the surfaces, to remain. Even with these improvements, coating remains inherently inefficient; powder is wasted and the time necessary for complete coating is too long for efficient production.

[0006] EP 0 307 642 A addresses the problem of coating different shaped electrically non-conducting hollow workpieces such as plastics bumpers for automobiles, with a support body at least approximately matched to the longitudinal and transverse extent of the hollow workpiece, by providing the support body to receive free edges of the workpiece, so that its hollow space is at least for the greater part closed by the support body; and an electrically conducting potential body is arranged in the resultant hollow space and at least approaches the inner surface of the workpiece facing the support body and forms a counter-terminal to an electrostatic coating located on the outside of the workpiece.

[0007] The present invention provides a method of producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the method comprising carrying the substrates on a support surface to a coating station at which they are held adjacent a source of particulate coating material, each substrate being associated with an individual location provided on the support surface which is electrically isolated from the remainder of the surface, and holding the substrates and the coating material at a potential difference to each other sufficient to coat the exposed surface of each substrate.

[0008] Preferably each substrate is at a potential difference to the remainder of the support surface. Preferably the remainder of the support surface is electrically conductive.

[0009] The present invention also provides a method for electrostatically coating a pharmaceutical substrate comprising bringing the substrate to a coating station at which it is held electrically isolated from, and preferably at a potential different to, its surroundings adjacent a source of particulate coating material, the substrate and the coating material being held at a potential difference to each other sufficient to coat the exposed surface of the substrate with particles of coating material.

[0010] Preferably at the coating station the substrate is supported by but electrically isolated from a support surface, which is electrically conductive.

[0011] Preferably the coating material particles are at a potential different to earth.

[0012] Advantageously, also, the potential difference to earth of the support surface and of the coating material are of the same sign, and for example the support surface may be at the same potential difference to earth as the coating material.

[0013] Preferably, the or each substrate is held at a potential difference to earth.

[0014] It is particularly preferred that the electric field between the coating material and the or each substrate is shaped. The field can be shaped so that the or each substrate is in a potential well. That is, the or each substrate is surrounded by a potential difference to earth different to its own, there being a sharp cut-off between the two potential differences. Thus, substantially all the coating material is attracted to the substrate, reducing waste of the coating material and avoiding the problems associated with coating material falling on the substrate surroundings.

[0015] Shaping of the field is achieved by manipulation of the potential difference between the or each substrate, its surroundings and the coating material. For example, a substrate is carried by but insulated from a surface, the surface being held at the same potential difference to earth as the coating material while the or each substrate is held at a

different potential difference to earth to that of the coating material. Coating material is therefore attracted to the substrate and not to the surface.

[0016] Preferably, substantially the only motive force between the substrate and the coating material is electrostatic. It may be desirable to provide particulate coating material in the form of a cloud of particles, formed for example by fluidising a bed of the coating material. Also preferably, the or each substrate is supported on, and in electrical contact with, an electrode while being otherwise electrically isolated from its surroundings.

[0017] For powder coating applications, the substrate may be brought to a pretreatment station at which the exposed surface of the or each substrate is coated with a capture-enhancing liquid. After coating with the coating material, the substrate(s) can be brought to a heating station where the coating material if powder is fused or if liquid is dried to an effectively continuous uniform coating. The reverse surfaces of the substrate can then be coated in the same way with the same coating material as the first-coated surface or with a different material. In this way, for example bi-coloured coated substrates may be produced. Preferably, the method is carried out continuously.

[0018] It is preferred that powders used in the method according to the invention has a resistivity greater than $10^8\Omega m$, preferably between 10^8 and $10^{15}\Omega m$.

[0019] Apparatus for electrostatically coating an electrically poorly conducting substrate according to the invention may comprise a coating station at which the substrate is substantially electrically isolated from, and preferably at a potential difference to, its surroundings adjacent means for supplying a particulate coating material, and means for holding a substrate and a coating material at a potential difference to each other. Preferably, the substrate is held at a potential difference to earth.

[0020] The invention especially provides apparatus for producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the apparatus comprising a support surface for carrying the substrates to a coating station at which the substrates are held adjacent means for supplying particulate coating material, the support surface being provided with a plurality of individual locations, each of which is electrically isolated from the remainder of the surface, and means for holding the substrates and the particulate coating material at a potential difference to each other.

[0021] Preferably, an electric field shaping device is associated with each substrate and shapes the field so that the substrate is in a potential well. Preferably, the electric field shaping device surrounds the substrate.

[0022] The apparatus advantageously includes an electrically conductive support surface such as a drum electrically isolated from the substrate which carries the substrate at least at the coating station. A field shaping device can be provided by provision for the support surface to be held at a potential difference to earth having the same sign as the potential difference to earth of the coating material.

[0023] In the case of powder coatings, the apparatus can include a pretreatment station for supplying capture-enhancing liquid to the exposed surface of the or each substrate and a conveyor for conveying the substrate between the pretreatment station and the coating station, the pretreatment station being upstream of the coating station. The conveyor is preferably a drum. The apparatus preferably includes a heating station downstream of the coating station for fusing the powder or drying the liquid coating material on the substrate to a film.

[0024] The invention further provides a drum for use as a support surface in an apparatus of the invention, the circumferential surface of the drum comprising a plurality of individual locations, each of which is electrically isolated from the remainder of the drum surface.

[0025] A coated pharmaceutical produced by the process of the invention may for example have one coating on one face and a different coating, or no coating, on the other face. The coatings may be of different colours or of different polymers or biologically active materials.

[0026] The source of particulate coating material, whether powder or liquid, may be a multiple source comprising several sub-sources. The sub-sources can be of different colour coating materials or of coating materials containing different polymers. Thus, tablets having more than one colour on a single surface can be provided. The faces can be bicoloured or striped. Similarly, a tablet can carry two or more different polymer coatings, side by side.

[0027] Thus, in a different embodiment, in a coated pharmaceutical produced by the process of the invention the surface of at least one face is two or more adjacent different coatings. The coatings may be of different colours or of different polymer composition.

[0028] The substrate, such as the core of a pharmaceutical tablet, may be completely electrically isolated from its surroundings, for example in free fall. Preferably, however, while coating takes place the or each substrate is in contact with an electrode through which it is maintained at a potential difference to earth (and to its surroundings). If the substrate is held on a support surface, such as the surface of a drum, it may sit in a depression in the support surface. The surface of the depression can be of a conductive material and form part of the electrode. The support surface may be surrounded by an arrangement of insulating, conducting or semiconducting areas which act to shape the electrical field pattern. The or each substrate is thus surrounded by a potential well, to ensure that charged particles of coating material are attracted to it, rather than to the surroundings, including the support surface, if any, carrying the substrate.

[0029] The invention will be further described, by way of example, with reference to the drawings, in which:

Figure 1 shows schematically a preferred embodiment of apparatus according to the invention;
Figure 2 shows diagrammatically a cross-section of a drum of the apparatus of Figure 1; and
Figure 3 shows diagrammatically means for providing droplets of liquid coating material for an apparatus according to the invention.

[0030] The apparatus shown schematically in Figure 1 is for coating both sides of pharmaceutical tablet cores. The apparatus comprises an inclined tablet core feed chute 10 leading to a first rotatable drum 12. The drum 12 is of plastic with a steel surface and has circular depressions 14 (Figure 2) in its outer surface in each of which a core can be held by vacuum, as will be explained later.

[0031] The drum 12 is rotatable in the direction shown by the arrow in Figure 1. Adjacent the circumference of the drum 12 downstream of the tablet feed chute 10 is a pre-conditioning station A comprising an electrostatic spray gun 16, which produces charged droplets which are attracted to the substrate cores on the drum by reason of the potential difference between the droplets and the cores. Downstream of the preconditioning station A is a coating station B comprising a vibrating powder tray 18 for holding, fluidising and re-circulating the powder with which the cores are to be coated. Downstream of the coating station is a fusing station C comprising a heater 20. After the fusing station C, the coated core passes a cooling station, not shown, where cool air is directed over or around the core to cool the fused coating.

[0032] A second drum 12' is adjacent the first drum 12, the nip between the drums being downstream of the fusing station C and the cooling station. The second drum 12' rotates in the opposite sense to the first drum 12, as indicated by the arrow in Figure 1. The second drum 12' is provided with a preconditioning station A' comprising a gun 16', a coating station B' comprising a powder tray 18', a fusing station C' comprising a heater 20' and a cooling station (not shown).

[0033] A core collection chute 22 inclines away from the second drum 12' downstream of the fusing station C', taking coated cores to be further processed and packed.

[0034] The first drum 12 will be described in more detail with reference to Figure 2. It comprises a rotatable shell 24, the outer face of which carries the depressions 14. In Figure 2, only five exemplary depressions 14 are shown; it will be appreciated that in practice there will usually be more depressions, evenly spaced in a circumferential row around the shell 24, and that there may be several circumferential rows across the width of the drum, whether formed by one continuous shell or several contiguous shells. The depressions 14 on the drums are shaped and dimensioned to ensure that the complete face of the core and half the depth of the side wall is coated while the core is on one drum. In the case of a circular tablet core, a depression diameter close to that of the core diameter is preferred. In some applications, the depth of the depression should be such as to allow at least 50% of the core thickness to be exposed to the particles of the coating material so that exposure of first one face of the core and then the other leads to complete coverage of the core.

[0035] The surface of each depression 14 is electrically insulated from the surfaces of other depressions on the drum and is provided with a pick up arm 26 extending radially inward, toward but ending short of the centre of the drum. The pick up arms 26 are attached to the inner surface of the shell 24 and rotate with it. The pick up arm 26 and the depression 14 together make a moving electrode to charge a core in a depression. Each depression 14 has means for holding the core against forces such as gravity, for example a passage 28 through its wall which can be in communication with a vacuum manifold 30 which extends around a portion of the periphery of the drum interior from immediately upstream of the core feed chute 10 to adjacent the nip between the first drum 12 and the second drum 12'.

[0036] A first, earthed, stationary arcuate electrode 32 is located inside the drum at an angular position corresponding to the preconditioning station A. A second stationary arcuate electrode 34 at a potential difference to earth is located inside the drum at an angular position corresponding to the coating station B. The outer arcuate surfaces of the stationary electrodes are at the same radial distance from the centre of the drum as the free ends of the pick up arms 26 of the moving electrodes. As the shell 24 rotates, the moving electrodes contact the first and second stationary electrodes sequentially.

[0037] The drum 12 is held at a potential difference to earth having the same sign as the potential difference to earth of the coating powder.

[0038] The second drum 12' is constructed similarly to the first drum, comprising a rotatable shell with depressions, pick up arms, first and second stationary electrodes and a vacuum manifold. The angular locations of the first and second stationary electrodes correspond to the second preconditioning station A' and the second coating station B', and the vacuum manifold extends from immediately upstream of the nip between the two drums to adjacent the core collection chute 22.

[0039] In use, cores are fed continuously to the core feed chute 10. A core passes down the core feed chute 10 into a depression 14 in the rotating shell 24 of the first drum 12. At that angular position, the depression overlies the vacuum manifold 30, and so the core is held in the depression by the vacuum through the passage 28 in the shell. The shell 24 continues to rotate bringing the core to the preconditioning station A, at which point the pick up arm 26 attached to

the depression 14 contacts the first stationary electrode 32, earthing the moving electrode and thus the core held in the depression. As the earthed tablet core passes the electrostatic spray gun 16, its exposed surface is sprayed with charged droplets of a capture-enhancing liquid, for example polyethylene glycol.

[0040] The shell 24 continues to rotate, taking the moving electrode 26 out of contact with the first stationary electrode 32 and bringing it into contact with the second stationary electrode 34, as the tablet core approaches the coating station B. The exposed polyethylene glycol treated core surface is now at a potential difference to earth, and coating powder is attracted to it from the powder tray 18. The potential well generated by holding the surface of the drum and the powder at the same potential difference to earth as each other and the core at a different potential difference to earth ensures that powder is attracted substantially only to the core and that the surface of the drum remains substantially free of powder.

[0041] The shell 24 continues to rotate, taking the moving electrode 26 out of contact with the second stationary electrode 34 and bringing the core to the fusing station C, where the heater 20 fuses the powder on the coated surface of the core to form an effectively continuous film.

[0042] As the shell 24 continues to rotate, the core leaves the fusing station C, passes through the cooling station (not shown), so that the depression carrying the core no longer overlies the vacuum manifold 30. The core drops from the first drum 12 into a depression on the outer surface of the second drum 12', with its uncoated surface uppermost; the depression is in communication with the vacuum manifold of the second drum. The coating of the core is completed as it travels past the second preconditioning A', coating B' and fusing C' stations. The coating powder at the second coating station may be the same as that at the first, or different. Thus, tablets having differently coated surfaces can be produced. Such dissimilar coatings can be used to provide functionally modified behaviour such as altered diffusion or dissolution controlled drug release or cosmetically different coatings such as those which would produce a bicoloured tablet. As the coated tablet draws adjacent the collection chute 22, the depression carrying it ceases to overlie the vacuum manifold, and the tablet falls into the chute and is further processed and packed.

[0043] The drums themselves are preferably at least 60 mm in diameter and not less than the minimum tablet diameter in width, rotating at least ½ r.p.m. The pressure in the vacuum manifold is sufficiently low to hold the tablet against gravity, preferably between 0.2 and 0.6 bar absolute.

[0044] In the electrostatic spray guns 16,16' at the preconditioning stations A,A', a semiconducting, non-volatile fluid, such as polyethylene glycol or an in aqueous solution thereof is fed at a rate of 0.1 to 1 ml/min. to a steel capillary of internal diameter 0.05 to 2 mm. The capillary is connected to a current limiced high voltage (up to 50 kV at 30 to 100 µA) potential difference to earth as each core on a drum passes the gun, and a mist of charged droplets is discharged from the capillary toward the core on the drum; since the cores on the drums are earthed at the preconditioning stations, the charged droplets are guided by the electric field between the capillary and the core to the exposed surface of the core, where they are captured. The cores may be held at a potential difference to earth at the preconditioning stations, providing that they are also at a potential difference to the capillaries. In this case, the first stationary arcuate electrode 32 is at a potential difference to earth. The supply of droplets from each capillary is controlled by switching the voltage off and earthing the capillary through a resistor (1 to 10 MΩ) as each core leaves the preconditioning station; this ensures a sharp cut off of the droplets between tablet cores.

[0045] The pre-conditioning step may not always be required.

[0046] At coating stations B,B', powdered coating material is supplied by vibrating feeders to the vibrating trays 18,18'. The level of the powder in the trays is determined by a levelling blade above each tray. The powder may be vibrofluidized and continuously recirculated. The trays may be of a plastics material having an earthed metal strip under the arc swept by the tablet cores on the respective drums or they may be metallic trays. An alternative way to charge the particles is triboelectrical charging. The trays are preferably 50 to 150 mm long and 3 to 40 mm wide. If more than one tray is used, to provide a bi- or multicoloured face or a face carrying more than one polymer composition, the tray dimensions will be appropriately different. The tablet cores are charged by a voltage of -3 to -15 kV current limited to 5 µA.

[0047] A preferred powder coating composition is:

46.5% by weight	Eudragit RS ammonio-methacrylate co-polymer
28.0% by weight	Klucel hydroxy propyl cellulose
15.0% by weight	titanium dioxide
5.0% by weight	aluminium lake
5.0% by weight	polyethylene glycol 6000
0.5% by weight	Aerosil 200 colloidal silicon dioxide

[0048] Another preferred powder coating composition is:

39.75% by weight	Eudragit RS ammonio-methacrylate co-polymer
39.75% by weight	Klucel (hydroxypropylcellulose)
15.0% by weight	Titanium dioxide
5.0% by weight	Aluminium lake
0.5% by weight	Aerosil (colloidal silicon dioxide)

[0049] The components are premixed under high shear, then wet granulated by mixing under high shear with water (10-15% by weight). The granulated mixture is dried in fluid bed drier at about 45°C for 20 to 30 minutesto reduce the moisture content to below 3% by weight. The dried granules are milled and micronised to a powder having a size distribution such that 50% by volume of the particles are of a size less than 20μm, and about 100% by volume are of a size less than 60μm. The peak size is about 10μm.

[0050] If the particulate coating material is liquid droplets, the apparatus is of a similar construction to that for applying powdered coating material to the cores. The vibrating trays holding the powder are replaced by means for producing liquid droplets with low momentum, such as that shown in Fig. 3. The apparatus may be designed so that a source of powder coating material may be easily replaced by a source of droplets of liquid coating material.

[0051] Droplets are produced by a spray gun 41 held at earth potential and electrically connected to the drum (12). The gun may be formed of metal or a polymer material. The direction of the spray is towards a baffle 42 down which the coalesced droplets can run into a re-circulating reservoir 43. The spray gun 41 produces a spray of relatively high initial momentum. This impinges on an internal baffle which breaks the spray up into a mist of droplets of low momentum. The momentum of the droplets produced by the spray gun is mainly in a direction normal to the substrate 44. If the substrate is uncharged there will be effectively no droplet capture onto the substrate surface. When the charge is applied to the substrate surface the droplets are attracted thereto to form a coating thereon which is later dried at a drying station similar to the fusing station C of the powder treatment apparatus. The pre-conditioning step A may be omitted in the case of liquid coating material.

[0052] A preferred liquid coating composition comprises:

hydroxypropylmethylcellulose	70%
glycerol	7%
iron oxide yellow	23%

in aqueous dispersion.

[0053] At the fusing or drying stations C,C', energy is imparted to the core surfaces to fuse the powder or dry the liquid and provide a uniform coating on the exposed surfaces of the core. The energy is provided by focused radiation preferably in the infra-red region; the energy power requirement will be determined largely by the coating material. After fusing or drying, the coating is set by cooling, using an air blower.

[0054] Preferred coating apparatus according to the invention can coat up to 300,000 tablet cores each hour.

Claims

1. A method of producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the method comprising carrying the substrates on a support surface (24) to a coating station (B) at which they are held adjacent a source of particulate coating material, each substrate being associated with an individual location (14) provided on the support surface which is electrically isolated from the remainder of the surface, and holding the substrates and the coating material at a potential difference to each other sufficient to coat the exposed surface of each substrate.

2. A method according to claim 1, in which each substrate is at a potential difference to the remainder of the support surface.

3. A method according to claim 1 or claim 2, in which the remainder of the support surface is electrically conductive.

4. A method of electrostatically coating a pharmaceutical substrate comprising bringing the substrate to a coating station (B) at which it is held substantially electrically isolated from its surroundings adjacent a source of particulate coating material, the substrate and the coating material being held at a potential difference to each other sufficient

to coat the exposed surface of the substrate with particles of coating material.

5. A method according to claim 4, in which the substrate is at a potential difference to its surroundings.

6. A method according to claim 4 or claim 5 in which at the coating station (B), the substrate is supported by but electrically isolated from a support surface (24), which is electrically conductive.

7. A method according to claim 3 or claim 6, in which the potential difference to earth of the support surface (24) and of the coating material are of the same sign.

8. A method according to claim 3, claim 6 or claim 7, in which the support surface (24) is at the same potential difference to earth as the coating material.

9. A method according to any one of claims 1 to 8, in which the electric field between the coating material and the or each substrate is shaped so that it is in a potential well.

10. A method according to any one of claims 1 to 9, in which the or each substrate is held at a potential difference to earth.

11. A method according to any one of claims 1 to 10, in which substantially the only motive force between the substrate (s) and the coating material is electrostatic.

12. A method according to any one of claims 1 to 11, in which the or each substrate is supported by, and in electrical contact with, an electrode (14, 26), the or each substrate being otherwise electrically isolated from its surroundings.

13. A method according to any one of claims 1 to 12, in which the coating material particles are at a potential different to earth.

14. A method according to any one of claims 1 to 13, in which a powdered coating material is used.

15. A method according to claim 14 further comprising bringing the substrate coated with powder to a fusing station (C) where the powder on the or each substrate is fused to a uniform coating.

16. A method according to claim 15, in which the fusing is by heating.

17. A method according to claim 15 or claim 16, further comprising cooling the fused coating on the substrate(s).

18. A method according to any one of claims 14 to 17, further comprising, prior to bringing the substrate(s) to the coating station, bringing the substrate(s) to a preconditioning station (A) at which the exposed surface of the or each substrate is coated with a capture-enhancing liquid.

19. A method according to claim 18, in which the coating carried out at the preconditioning station (A) is electrostatic coating.

20. A method according to claim 18 or claim 19, in which the capture-enhancing liquid is partially conducting.

21. A method according to any one of claims 1 to 13, in which the coating material is liquid.

22. A continuous method according to any one of claims 1 to 21, in which the substrate(s) are carried by a moving surface (24).

23. A continuous method according to claim 22, in which the substrate(s) are carried by the surface of a rotating drum (12).

24. A continuous method according to claim 22 or claim 23, in which the or each substrate is held in a depression (14) in the surface, the depression being electrically isolated from the remainder of the surface.

25. A method according to any one of claims 1 to 24, in which the or each substrate is held in contact with an electrode

(14, 26) at least while it is at the coating station.

26. A method according to any one of claims 1 to 25, further comprising turning the or each substrate after application of a coating to a first surface of the substrate and applying a coating to a second surface of the or each substrate.

27. A method according to any one of claims 1 to 26, in which the or each substrate is a solid pharmaceutical dosage form.

28. A method according to claim 27, in which the or each substrate is a tablet core.

29. A method according to claim 27 or claim 28, in which the dosage form produced has one coated face and one uncoated face.

30. A method according to claim 27 or claim 28, in which the dosage form produced has one coating on one face and a different coating on the other face.

31. A method according to claim 27 or claim 28, in which the dosage form produced has, on the surface of one face, two or more adjacent different coatings.

32. A method according to claim 30 or claim 31, in which the coatings are of different colours.

33. A method according to any of claims 1 to 32, in which the coating contains biologically active material.

34. Apparatus for producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the apparatus comprising a support surface (24) for carrying the substrates to a coating station (B) at which the substrates are held adjacent means for supplying particulate coating material, the support surface (24) being provided with a plurality of individual locations (14), each of which is electrically isolated from the remainder of the surface, and means for holding the substrates and the particulate coating material at a potential difference to each other.

35. Apparatus according to claim 34, including means for holding a substrate at a potential difference to the remainder of the support surface at the coating station.

36. Apparatus according to claim 34 or claim 35, in which an electric field shaping device is associated with each substrate, and shapes the field so that the substrate is in a potential well.

37. Apparatus according to claim 36, in which the electric field shaping device surrounds the substrate.

38. Apparatus according to any one of claims 34 to 37, in which the support surface is conductive.

39. Apparatus according to any one of claims 34 to 38, in which the potential difference of the support surface to earth and of the coating material to earth are of the same sign.

40. Apparatus according to any one of claims 34 to 39, including means (14, 26, 34) for holding each substrate at the coating station at a potential difference to earth.

41. Apparatus according to any one of claims 34 to 40, further including a fusing station (C) downstream of the coating station (B) for fusing a powdered coating material on each substrate to a film.

42. Apparatus according to claim 41, in which the fusing station comprises a heater.

43. Apparatus according to claim 41 or claim 42, further including a cooling station downstream of the fusing station.

44. Apparatus according to any one of claims 34 to 43, further including a preconditioning station (A) for supplying capture-enhancing liquid to the exposed surface of each substrate and a conveyor (24) for conveying the substrates between the preconditioning station and the coating station, the preconditioning station being upstream of the coating station.

45. Apparatus according to claim 44, in which the preconditioning station (A) comprises an electrostatic spray gun (16) for supplying the capture-enhancing liquid.

46. Apparatus according to any one of claims 34 to 45, including a plurality of electrodes (14, 26) each disposed to contact a substrate at the coating station.

47. Apparatus according to claim 46, in which the electrodes (16, 26) form part of the support surface.

48. Apparatus according to any one claims 34 to 47, in which the support surface is continuous.

49. Apparatus according to claim 48, in which the support surface is a conveyor (24) disposed between the coating and fusing stations to move the substrates from the coating station to the fusing station.

50. Apparatus according to claim 49, in which the conveyor is the outer surface of a rotating drum (12) having discrete areas (14) electrically isolated from the drum surface for the reception of respective substrates.

51. Apparatus according to claim 50, in which the areas (14) are depressions in the said surface of the drum.

52. Apparatus according to claim 50 or claim 51, further including a second drum (12') and second coating and fusing stations (A' and B'), the second drum being so disposed relative to the first drum (12) that substrates leaving the first drum (12) with a coated surface are transferred onto the second drum (12') with an uncoated surface exposed.

53. Apparatus according to any one of claims 50 to 52, including a vacuum device for holding the substrates on the support surface.

54. A drum for use as a support surface in apparatus according to any of claims 34 to 53, the circumferential surface of the drum comprising a plurality of individual locations (14), each of which is electrically isolated from the remainder of the drum surface.

55. A drum according to claim 54, in which the individual locations (14) are depressions in the surface of the drum.

Patentansprüche

1. Verfahren zum Herstellen einer Mehrzahl von beschichteten Substraten, von denen jedes ein elektrisch schlecht leitendes Substrat umfasst, das mit einem Beschichtungsmaterial auf elektrostatische Weise beschichtet ist, wobei das Verfahren umfasst
Befördern der Substrate auf einer Trägeroberfläche (24) zu einer Beschichtungsstation (B), bei der sie benachbart zu einer Quelle eines partikelförmigen Beschichtungsmaterials gehalten werden, wobei jedes Substrat einer individuellen Stelle (14) zugeordnet ist, die auf der Trägeroberfläche vorgesehen ist und die elektrisch von dem Rest der Oberfläche isoliert ist, und
Halten der Substrate und des Beschichtungsmaterials auf einer Potentialdifferenz zueinander, die ausreicht, um die freie Oberfläche jedes Substrats zu beschichten.

2. Verfahren nach Anspruch 1, bei dem sich jedes Substrat auf einer Potentialdifferenz zu dem Rest der Trägeroberfläche befindet.

3. Verfahren nach Anspruch 1 oder Anspruch 2, bei dem der Rest der Trägeroberfläche elektrisch leitend ist.

4. Verfahren zum elektrostatischen Beschichten eines pharmazeutischen Substrats, das Bringen des Substrats zu einer Beschichtungsstation (B) umfasst, bei der es im wesentlichen elektrisch von seiner Umgebung isoliert benachbart zu einer Quelle eines partikelförmigen Beschichtungsmaterials gehalten wird, wobei das Substrat und das Beschichtungsmaterial auf einer Potentialdifferenz zueinander gehalten werden, die ausreicht, um die freie Oberfläche des Substrats mit Partikeln des Beschichtungsmaterials zu beschichten.

5. Verfahren nach Anspruch 4, bei dem sich das Substrat auf einer Potentialdifferenz zu seiner Umgebung befindet.

6. Verfahren nach Anspruch 4 oder Anspruch 5, bei dem das Substrat bei der Beschichtungsstation (B) von einer

elektrisch leitenden Trägeroberfläche (24) getragen wird, aber davon elektrisch isoliert ist.

7. Verfahren nach Anspruch 3 oder Anspruch 6, bei dem die Potentialdifferenz der Trägeroberfläche (24) und des Beschichtungsmaterials zu Erde dasselbe Vorzeichen hat.

8. Verfahren nach Anspruch 3, Anspruch 6 oder Anspruch 7, bei dem sich die Trägeroberfläche (24) auf derselben Potentialdifferenz zu Erde befindet, wie das Beschichtungsmaterial.

9. Verfahren nach einem der Ansprüche 1 bis 8, bei dem das elektrische Feld zwischen dem Beschichtungsmaterial und dem oder jedem Substrat so geformt ist, das es sich in einer Potentialmulde befindet.

10. Verfahren nach einem der Anspruche 1 bis 8, bei dem das oder jedes Substrat auf einer Potentialdifferenz zu Erde gehalten wird.

11. Verfahren nach einem der Ansprüche 1 bis 10, bei dem im wesentlichen die einzige Antriebskraft zwischen dem/den Substrat(en) und dem Beschichtungsmaterial elektrostatisch ist.

12. Verfahren nach einem der Ansprüche 1 bis 11, bei dem das oder jedes Substrat von einer Elektrode (14, 26) getragen ist und mit ihr in elektrischem Kontakt ist, wobei das oder jedes Substrat ansonsten elektrisch von seiner Umgebung isoliert ist.

13. Verfahren nach einem der Ansprüche 1 bis 12, bei dem sich die Beschichtungsmaterialpartikel auf einem von Erde verschiedenen Potential befinden.

14. Verfahren nach einem der Ansprüche 1 bis 13, bei dem eine pulverisiertes Beschichtungsmaterial verwendet wird.

15. Verfahren nach Anspruch 14, das weiter Bringen des mit Pulver beschichteten Substrats zu einer Schmelzstation (C) umfasst, wo das Pulver auf dem oder den Substrat(en) zu einer gleichmäßigen Beschichtung geschmolzen wird.

16. Verfahren nach Anspruch 15, bei dem das Schmelzen durch Heizen erfolgt.

17. Verfahren nach Anspruch 15 oder Anspruch 16, das weiter Kühlen der geschmolzenen Beschichtung auf dem/den Substrat(en) umfasst.

18. Verfahren nach einem der Ansprüche 14 bis 17, das weiter vor dem Bringen des Substrats/der Substrate zu der Beschichtungsstation Bringen des Substrats/der Substrate zu einer Vorbehandlungsstation (A) umfasst, bei der die freie Oberfläche des Substrats oder der Substrate mit einer Einfang-verstärkenden Flüssigkeit beschichtet wird.

19. Verfahren nach Anspruch 18, bei dem das Beschichten, das bei der Vorbehandlungsstation (A) ausgeführt wird, ein elektrostatisches Beschichten ist.

20. Verfahren nach Anspruch 18 oder Anspruch 19, bei dem die Einfangverstärkende Flüssigkeit teilweise leitend ist.

21. Verfahren nach einem der Ansprüche 1 bis 13, bei dem das Beschichtungsmaterial flüssig ist.

22. Kontinuierliches Verfahren nach einem der Ansprüche 1 bis 21, bei dem das/die Substrat(e) von einer sich bewegenden Oberfläche (24) getragen werden.

23. Kontinuierliches Verfahren nach Anspruch 22, bei dem das/die Substrat(e) von der Oberfläche einer sich drehenden Trommel (12) getragen werden.

24. Kontinuierliches Verfahren nach Anspruch 22 oder Anspruch 23, bei dem das oder jedes Substrat in einer Vertiefung (14) in der Oberfläche gehalten wird, wobei die Vertiefung elektrisch von dem Rest der Oberfläche isoliert ist.

25. Verfahren nach einem der Ansprüche 1 bis 24, bei dem das oder jedes Substrat, mindestens während es sich bei der Beschichtungsstation befindet, mit einer Elektrode (14, 26) in Kontakt gehalten wird.

26. Verfahren nach einem der Ansprüche 1 bis 25, das weiter Drehen des oder jedes Substrats nach dem Aufbringen einer Beschichtung auf eine erste Oberfläche des Substrats und Aufbringen einer Beschichtung auf eine zweite Oberfläche des oder jedes Substrats umfasst.

27. Verfahren nach einem der Ansprüche 1 bis 26, bei dem das oder jedes Substrat eine feste pharmazeutische Dosierform ist.

28. Verfahren nach Anspruch 27, bei dem das oder jedes Substrat ein Tablettenkern ist.

29. Verfahren nach Anspruch 27 oder Anspruch 28, bei dem die hergestellte Dosierform eine beschichtete Seite und eine unbeschichtete Seite besitzt.

30. Verfahren nach Anspruch 27 oder Anspruch 28, bei den die hergestellte Dosierform eine Beschichtung auf einer Seite und eine unterschiedliche Beschichtung auf der anderen Seite besitzt.

31. Verfahren nach Anspruch 27 oder Anspruch 28, bei dem die hergestellte Dosierform auf der Oberfläche einer Seite zwei oder mehr benachbarte unterschiedliche Beschichtungen besitzt.

32. Verfahren nach Anspruch 30 oder Anspruch 31, bei dem die Beschichtungen von unterschiedlichen Farben sind.

33. Verfahren nach einem der Ansprüche 1 bis 32, bei dem die Beschichtung ein biologisch aktives Material enthält.

34. Vorrichtung zum Herstellen einer Mehrzahl von beschichteten Substraten, von denen jedes ein elektrisch schlecht leitendes Substrat umfasst, das auf elektrostatische Weise mit einem Beschichtungmaterial beschichtet ist, wobei die Vorrichtung eine Trägeroberfläche (24) zum Tragen der Substrate zu einer Beschichtungsstation (B), bei der die Substrate benachbart zu Mitteln zum Liefern von partikelförmigen Beschichtungsmaterial gehalten werden, wobei die Trägeroberfläche (24) mit einer Mehrzahl von individuellen Stellen (14) versehen ist, von denen jede elektrisch von dem Rest der Oberfläche isoliert ist, und
Mittel zum Halten der Substrate und des partikelförmigen Beschichtungsmaterials auf einer Potentialdifferenz zueinander umfasst.

35. Vorrichtung nach Anspruch 34, die Mittel zum Halten eines Substrats auf einer Potentialdifferenz zu dem Rest der Trägeroberfläche bei der Beschichtungsstation aufweist.

36. Vorrichtung nach Anspruch 34 oder Anspruch 35, bei der eine Einrichtung zum Formen eines elektrischen Feldes mit jedem Substrat in Verbindung steht und das Feld derart formt, dass sich das Substrat in einer Potentialmulde befindet.

37. Vorrichtung nach Anspruch 36, bei der die Einrichtung zum Formen eines elektrischen Feldes das Substrat umgibt.

38. Vorrichtung nach einem der Ansprüche 34 bis 37, bei der die Trägeroberfläche leitend ist.

39. Vorrichtung nach einem der Ansprüche 34 bis 38, bei der die Potentialdifferenz der Trägeroberfläche zu Erde und des Beschichtungsmaterials zu Erde von demselben Vorzeichen sind.

40. Vorrichtung nach einem der Ansprüche 34 bis 39, das Mittel (14, 26, 34) zum Halten jedes Substrats bei der Beschichtungsstation auf einer Potentialdifferenz zu Erde aufweist.

41. Vorrichtung nach einem der Ansprüche 34 bis 40, die weiter eine der Beschichtungsstation (B) nachgeschaltete Schmelzstation (C) zum Schmelzen eines pulverisierten Beschichtungsmaterials auf jedem Substrat zu einem Film aufweist.

42. Vorrichtung nach Anspruch 41, bei der die Schmelzstation einen Heizer umfasst.

43. Vorrichtung nach Anspruch 41 oder Anspruch 42, die weiter eine der Schmelzstation nachgeschaltete Kühlstation aufweist.

44. Vorrichtung nach einem der Ansprüche 34 bis 43, die weiter eine Vorbehandlungsstation (A) zum Liefern einer

Einfang-verstärkenden Flüssigkeit auf die freie Oberfläche jedes Substrats und ein Fördermittel (24) zum Befördern der Substrate zwischen der Vorbehandlungsstation und der Beschichtungsstation aufweist, wobei die Vorbehandlungsstation der Beschichtungsstation vorgeschaltet ist.

45. Vorrichtung nach Anspruch 44, bei der die Vorbehandlungsstation (A) eine Kanone (16) für ein elektrostatisches Spray zum Liefern der Einfang-verstärkenden Flüssigkeit umfasst.

46. Vorrichtung nach einem der Ansprüche 34 bis 45, die eine Mehrzahl von Elektroden (14, 26) umfasst, die jeweils angeordnet sind, um mit einem Substrat bei der Beschichtungsstation in Kontakt zu stehen.

47. Vorrichtung nach Anspruch 46, bei der die Elektroden (16, 26) einen Teil der Trägeroberfläche bilden.

48. Vorrichtung nach einem der Ansprüche 34 bis 47, bei der die Trägeroberfläche kontinuierlich ist.

49. Vorrichtung nach Anspruch 48, bei der die Trägeroberfläche ein Fördermittel (24) ist, das zwischen der Beschichtungs- und der Schmelzstation angeordnet ist, um die Substrate von der Beschichtungsstation zu der Schmelzstation zu bewegen.

50. Vorrichtung nach Anspruch 49, bei der das Fördermittel die äußere Oberfläche einer sich drehenden Trommel (12) ist, die getrennte, von der Trommeloberfläche elektrisch isolierte Flächen (14) zur Aufnahme der jeweiligen Substrate aufweist.

51. Vorrichtung nach Anspruch 50, bei, der die Flächen (14) Vertiefungen in der Oberfläche der Trommel sind.

52. Vorrichtung nach Anspruch 50 oder Anspruch 51, die weiter eine zweite Trommel (12') und zweite Beschichtungs- und Schmelzstation (A' und B') aufweist, wobei die zweite Trommel derart relativ zu der ersten Trommel (12) angeordnet ist, dass Substrate, die die erste Trommel (12) mit einer beschichteten Oberfläche verlassen, auf die zweite Trommel (12') übertragen werden, wobei eine unbeschichtete Oberfläche frei ist.

53. Vorrichtung nach einem der Ansprüche 50 bis 52, die eine Vakuumeinrichtung zum Halten der Substrate auf der Trägeroberfläche aufweist.

54. Trommel zur Verwendung als eine Trägeroberfläche in einer Vorrichtung nach einem der Ansprüche 34 bis 53, bei der die Umfangsoberfläche der Trommel eine Mehrzahl von individuellen Stellen (14) umfasst, von denen jede von dem Rest der Trommeloberfläche elektrisch isoliert ist.

55. Trommel nach Anspruch 54, bei der die individuellen Stellen (14) Vertiefungen in der Oberfläche der Trommel sind.

Revendications

1. Procédé de production d'une pluralité de substrats revêtus, chacun comprenant un substrat électriquement mauvais conducteur revêtu de façon électrostatique d'un matériau de revêtement, le procédé comprenant le transport des substrats sur une surface porteuse (24) jusqu'à un poste de revêtement (B) dans lequel ils sont placés de façon adjacente à une source de matériau de revêtement en particules, chaque substrat étant associé à un endroit particulier (14) prévu sur la surface porteuse qui est isolé électriquement du reste de la surface, et le maintien des substrats et du matériau de revêtement à une différence de potentiel mutuelle suffisante pour revêtir la surface accessible de chaque substrat.

2. Procédé selon la revendication 1, dans lequel chaque substrat est à une différence de potentiel par rapport au reste de la surface porteuse.

3. Procédé selon l'une des revendications 1 et 2, dans lequel le reste de la surface porteuse est électriquement conducteur.

4. Procédé de revêtement électrostatique d'un substrat pharmaceutique comprenant le transport du substrat à un poste de revêtement (B) dans lequel il est maintenu sensiblement électriquement isolé de ce qui l'entoure près d'une source de matériau de revêtement en particules, le substrat et le matériau de revêtement étant maintenus

à une différence de potentiel mutuelle suffisante pour revêtir la surface accessible du substrat par des particules de matériau de revêtement.

5. Procédé selon la revendication 4, dans lequel le substrat est à une différence de potentiel par rapport à ce qui l'entoure.

6. Procédé selon l'une des revendications 4 et 5, dans lequel, au poste de revêtement (B), le substrat est porté par une surface porteuse (24) qui est électriquement conductrice mais il en est isolé électriquement.

7. Procédé selon la revendication 3 ou 6, dans lequel les différences de potentiel par rapport à la terre de la surface porteuse (24) et du matériau de revêtement sont de même signe.

8. Procédé selon l'une des revendications 3, 6 et 7, dans lequel la surface porteuse (24) est à la même différence de potentiel que le matériau de revêtement.

9. Procédé selon l'une des revendications 1 à 8, dans lequel le champ électrique entre le matériau de revêtement et le ou chaque substrat est conformé de sorte qu'il est dans un puits de potentiel.

10. Procédé selon l'une des revendications 1 à 9, dans lequel le ou chaque substrat est maintenu à une différence de potentiel par rapport à la terre.

11. Procédé selon l'une des revendications 1 à 10, dans lequel sensiblement la seule force motrice entre le ou les substrat(s) et le matériau de revêtement est électrostatique.

12. Procédé selon l'une des revendications 1 à 11, dans lequel le ou les substrats sont portés par, et en contact électrique avec, une électrode (14, 26), le ou chaque substrat étant par ailleurs isolé électriquement de ce qui l'entoure.

13. Procédé selon l'une des revendications 1 à 12, dans lequel les particules de matériau de revêtement sont à un potentiel différent de la terre.

14. Procédé selon l'une des revendications 1 à 13, dans lequel est utilisé un matériau de revêtement en poudre.

15. Procédé selon la revendication 14, comprenant en outre le transport du substrat revêtu à un poste de fusion (C) où la poudre sur le ou chaque substrat est fondue en un revêtement uniforme.

16. Procédé selon la revendication 15, dans lequel la fusion s'effectue par chauffage.

17. Procédé selon l'une des revendications 15 et 16, comprenant en outre le refroidissement du revêtement fondu sur le(s) substrat(s).

18. Procédé selon l'une quelconque des revendications 14 à 17, comprenant en outre, avant le transport du ou des substrats au poste de revêtement, le transport du ou des substrats à un poste de préconditionnement (A) dans lequel la surface accessible du ou des substrats est revêtue d'un liquide favorisant la capture.

19. Procédé selon la revendication 18, dans lequel l'opération de revêtement effectuée dans le poste de préconditionnement (A) est un revêtement électrostatique.

20. Procédé selon l'une des revendications 18 et 19, dans lequel le liquide favorisant la capture est partiellement conducteur.

21. Procédé selon l'une quelconque des revendications 1 à 13, dans lequel le matériau de revêtement est liquide.

22. Procédé continu selon l'une quelconque des revendications 1 à 21, dans lequel le ou les substrats sont transportés par une surface mobile (24).

23. Procédé continu selon la revendication 22, dans lequel le ou les substrats sont portés par la surface d'un tambour rotatif (12).

24. Procédé continu selon l'une des revendications 22 et 23, dans lequel le ou chaque substrat est maintenu dans un creux (14) de la surface, le creux étant électriquement isolé du reste de la surface.

25. Procédé selon l'une quelconque des revendications 1 à 24, dans lequel le ou chaque substrat est maintenu en contact avec une électrode (14, 26) au moins pendant qu'il se trouve dans le posté de revêtement.

26. Procédé selon l'une quelconque des revendications 1 à 25, comprenant en outre le retournement dû ou de chaque substrat après application d'un revêtement à une première surface du substrat et l'application d'un revêtement sur une seconde surface du ou de chaque substrat.

27. Procédé selon l'une quelconque des revendications 1 à 26, dans lequel le ou chaque substrat est sous forme de dosage pharmaceutique solide.

28. Procédé selon la revendication 27, dans lequel le ou chaque substrat est une âme de plaquette.

29. Procédé selon l'une des revendications 27 et 28, dans lequel la forme de dosage produite comporte une face revêtue et une face non revêtue.

30. Procédé selon l'une des revendications 27 et 28, dans lequel la forme de dosage produite comporte un revêtement sur une face et un revêtement différent sur l'autre face.

31. Procédé selon l'une des revendications 27 et 28, dans lequel la forme de dosage produite comporte, sur la surface d'une face, deux revêtements différents adjacents ou plus.

32. Procédé selon l'une des revendications 30 et 31, dans lequel les revêtements sont de différentes couleurs.

33. Procédé selon l'une quelconque des revendications 1 à 32, dans lequel le revêtement contient un matériau biologiquement actif.

34. Appareil de production d'une pluralité de substrats revêtus, chacun comprenant un substrat électriquement mauvais conducteur revêtu de façon électrostatique d'un matériau de revêtement, l'appareil comprenant une surface porteuse (24) pour transporter les substrats jusqu'à un poste de revêtement (B) dans lequel les substrats sont maintenus à côté de moyens de fourniture de matériau de revêtement en particules, la surface porteuse (24) comportant une pluralité d'endroits individuels (14), chacun d'entre eux électriquement isolé du reste de la surface, et des moyens de maintien des substrats et du matériau de revêtement en particules à une différence de potentiel mutuelle.

35. Appareil selon la revendication 34, comprenant des moyens pour maintenir un substrat à une différence de potentiel par rapport au reste de la surface porteuse dans le poste de revêtement.

36. Appareil selon l'une des revendications 34 et 35, dans lequel un dispositif de mise en forme de champ électrique est associé à chaque substrat et met en forme le champ de sorte que le substrat se trouve dans un puits de potentiel.

37. Appareil selon la revendication 36, dans lequel le dispositif de mise en forme de champ électrique entoure le substrat.

38. Appareil selon l'une quelconque des revendications 34 à 37, dans lequel la surface porteuse est conductrice.

39. Appareil selon l'une quelconque des revendications 34 à 38, dans lequel les différences de potentiel de la surface porteuse par rapport à la terre et du matériau de revêtement par rapport à la terre sont les mêmes.

40. Appareil selon l'une quelconque des revendications 34 à 39, comprenant des moyens (14, 26, 34) de maintien de chaque substrat dans le poste de revêtement à une certaine différence de potentiel par rapport à la terre.

41. Appareil selon l'une quelconque des revendications 34 à 40, comportant en outre un poste de fusion (C) en aval du poste de revêtement (B) pour faire fondre le matériau de revêtement sur chaque substrat selon un film.

42. Appareil selon la revendication 41, dans lequel le poste de fusion comprend un dispositif de chauffage.

43. Appareil selon l'une des revendications 41 et 42, comprenant en outre un poste de refroidissement en aval du poste de fusion.

44. Appareil selon l'une quelconque des revendications 34 à 43, comprenant en outre un poste de préconditionnement (A) pour fournir du liquide facilitant la capture à la surface accessible de chaque substrat et un convoyeur (24) pour convoyer les substrats entre le poste de préconditionnement et le poste de revêtement, le poste de préconditionnement étant en aval du poste de revêtement.

45. Appareil selon la revendication 44, dans lequel le poste de préconditionnement (A) comprend un canon de brumisation électrostatique (16) pour fournir le liquide facilitant la capture.

46. Appareil selon l'une quelconque des revendications 34 à 45, comprenant une pluralité d'électrodes (14, 26) placées chacune en contact avec un substrat dans le poste de revêtement.

47. Appareil selon la revendication 46, dans lequel les électrodes (16, 26) font partie de la surface porteuse.

48. Appareil selon l'une des revendications 34 à 47, dans lequel la surface porteuse est continue.

49. Appareil selon la revendication 48, dans lequel la surface porteuse est un convoyeur (24) situé entre le poste de revêtement et le poste de fusion pour déplacer les substrats du poste de revêtement au poste de fusion.

50. Appareil selon la revendication 49, dans lequel le convoyeur est la surface externe d'un tambour rotatif (12) ayant des zones discrètes (14) électriquement isolées de la surface du tambour pour recevoir les substrats respectifs.

51. Appareil selon la revendication 50, dans lequel les zones (14) sont des creux dans la dite surface du tambour.

52. Appareil selon l'une des revendications 50 et 51, comprenant en outre un second tambour (12') et des seconds postes de revêtement et de fusion (A' et B'), le second tambour étant placé par rapport au premier tambour (12) de façon que les substrats quittant le premier tambour (12) avec une surface revêtue sont transférés sur le second tambour (12') avec une surface accessible non revêtue.

53. Appareil selon l'une quelconque des revendications 50 à 52, comprenant un dispositif à vide de maintien des substrats sur la surface porteuse.

54. Tambour utilisable comme surface porteuse dans un appareil selon l'une quelconque des revendications 34 à 53, la surface circonférentielle du tambour comprenant une pluralité d'endroits individuels (14), chacun d'entre eux étant électriquement isolé du reste de la surface de tambour.

55. Tambour selon la revendication 54, dans lequel les endroits individuels (14) sont des creux dans la surface du tambour.

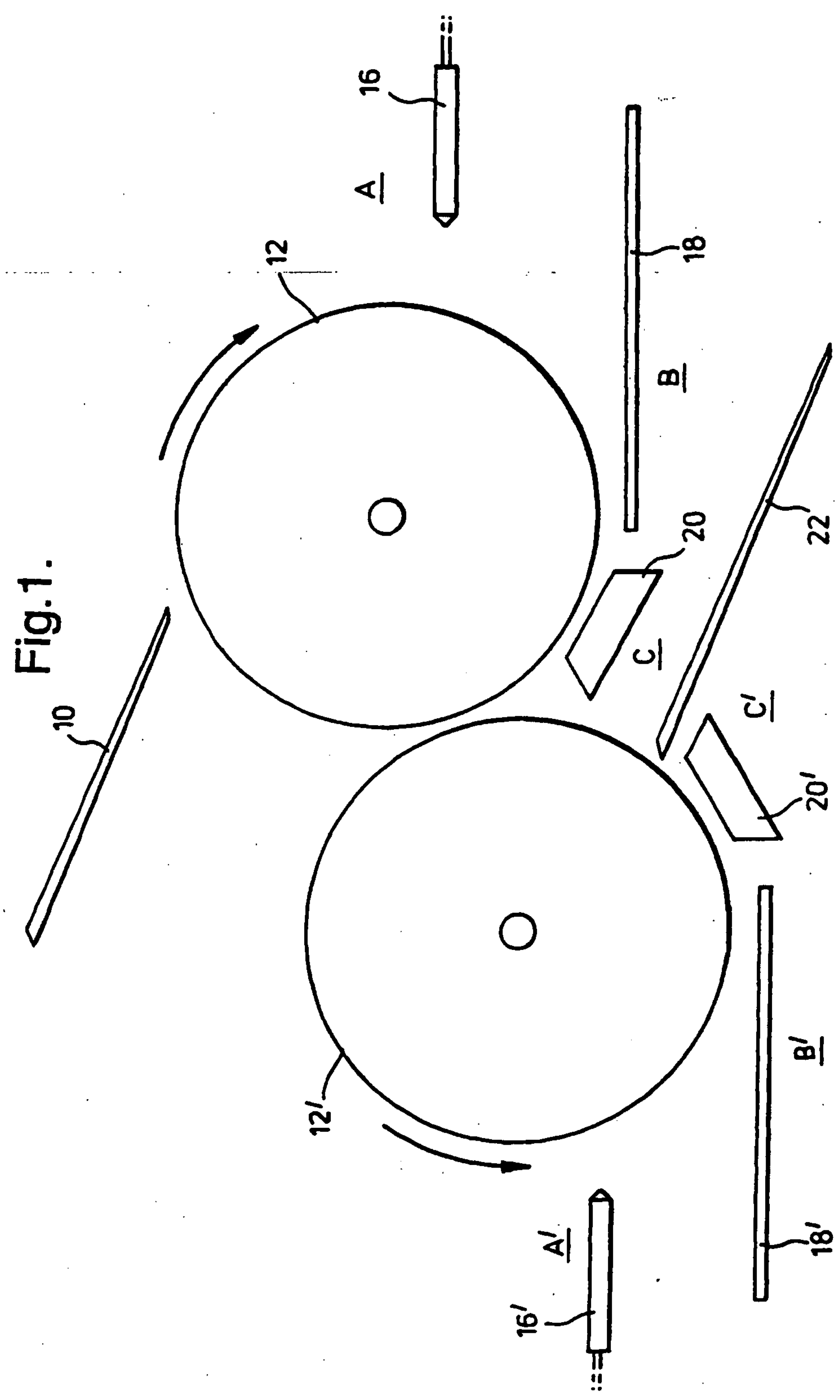

Fig.1.

Fig.2.

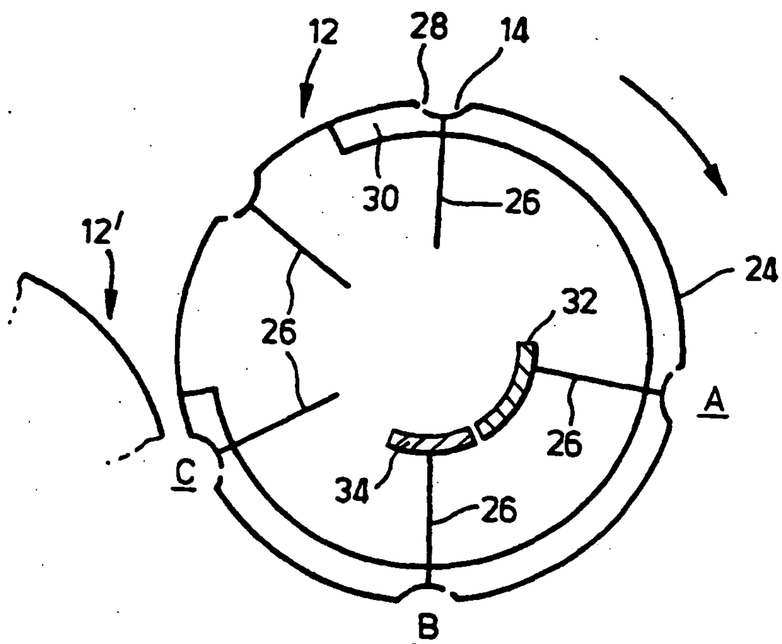

Fig.3.